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To facilitate the use of operant audiometry with low functioning children (psychotic, severely retarded, or multiply handicapped), a procedures manual was developed containing definitions of terms, instructions for determining reinforcers, physical facilities and equipment needs, diagrams, component lists, and technical descriptions. Development of the method began with the child brought into the testing room by the trainer who assisted the child in pushing a button when a tone was presented. Reinforcements were presented after each push until the child was responding appropriately; conditioning occurred at different frequencies and with changing reinforcement schedules, and the child was conditioned to wear earphones. The final hearing test was then conducted. Instructions are provided for the trainer who attempted to consider possible reactions by the subjects and provided for fading out assistance; directions for the examiner, who operated the equipment, are also included. An auxiliary program using a tone-light combination is included for children who did not respond to the above procedures. (JB)

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OPERANT AUDIOMETRY MANUAL FOR DIFFICULT-TO-TEST CHILDREN

by

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Operant Audiometry Manual for Difficult-To-Test Children[1]

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INTRODUCTION

The rising concern for the training of low-functioning children (psychotic, severely retarded, or multiple handicapped) has produced a need for a technology of education which is sensitive to the learning and motivational characteristics of these children. Some aspects of this new technology have started to emerge in the areas of self-help skills (Bensberg, Colwell, & Cassel, 1965), toilet training (Giles & Wolf, 1966), and the elimination of deviant behavior (Wolf, Risley, & Mees, 1964). Recent efforts have been made to extend the technology of education for low-functioning children to more meaningful aspects of human development, especially speech and language (Risley & Wolf, 1968; Lovaas, 1968). The emphasis on the area of language is understandable as it is the basis for communication and cognitive development. Since the type of language training to be used is dependent on the child's hearing level, it is important that an accurate auditory assessment technique be developed for low-functioning children who are typically difficult to test. Among the various techniques that have been tried, the use of EEG assessment and operant audiometry appear to offer the most promise. Of these two techniques, operant audiometry is favored by the present writers for two reasons. First, operant audiometry depends on a sequence of reinforcement and behavior control techniques which are useful in all subsequent aspects of speech and language

training. EEG audiometry has no subsequent advantage in other areas of behavioral education or training. Second, the cost of an apparatus for operant audiometry can be as low as $20.00, while an EEG recording device is considerably more expensive.

The purpose of this manual is to provide a description of a step-by-step procedure for using operant audiometry with low-functioning children. The sequence is described in detail so that a person who is unfamiliar with operant techniques can use the method without additional instruction. The procedures described below were derived from an investigation comparing four different operant audiometry procedures with low-functioning children (Bricker & Bricker, 1968).

DIRECTIONS FOR USE OF THE MANUAL

The program for the child is structured in a sequence of training steps, each of which should be completed before the next step is begun. This sequence of steps insures, to some degree, that the child has the appropriate repertoire and is under appropriate stimulus control in each stage of training and testing. After the user develops competence in the use of the technique, he will no doubt find ways to shorten the process as well as deal with a wider range of children.

Until becoming familiar with the technique it is recommended that the first subjects be carefully selected using the following criteria: a child who (1) likes candy, cereal, pretzels, or some other easy-to-dispense edible; (2) is not self-injurious or

dangerous to others; (3) is willing to sit for short periods of time; (4) is capable of pushing a button without much physical difficulty; (5) is toilet trained; and (6) is not suspected of being deaf.

The amount of time needed to complete this testing program will vary greatly depending on the child. Some children may be adequately evaluated in an hour, while an accurate assessment for others may take substantially longer.

DEFINITION OF TERMS

Reinforcement

Reinforcement is operationally defined as any stimulus which follows a particular response and is associated with an increase in the probability of that particular response occurring again. For example, if M&Ms were made contingent on a child's button-pushing response and the rate at which the child pressed the button increased, the M&Ms could be appropriately labeled a reinforcer for that child. On the other hand, if patting the child on the head, contingent on button pushing, decreased the rate of button pushing, a pat on the head could not be construed as a reinforcer for that child. A reinforcer can only be determined through empirical validation.

Discriminable Stimulus

The discriminable stimulus (often referred to as the SD) in this program is the tone or the light. The tone-on (SD) indicates to the child that button pushing will be reinforced.

The alternative to the SD is the S Delta (SΔ) which is tone-off or light-off in this program and indicates non-reinforcement or the extinction condition.

Schedules of Reinforcement

The schedule of reinforcement refers, among other arrangements, to the number of times a child will have to emit a specific behavior in order to be reinforced. Since the behavior of interest in the present program is button pushing in the presence of a tone, it will be used for illustration. An FR 1 (Fixed-Ratio) means that each time the child depresses the button in the tone-on condition he will receive a reinforcement. An FR 5 schedule means that the child must depress the button in the presence of the tone five consecutive times before a reinforcement will be dispensed. Thus, the numeral following the FR indicates the number of responses necessary to acquire each reinforcement. During the SΔ condition (tone-off) the child is on an extinction schedule, which means he will receive no reinforcement for depressing the button as long as the tone is off.

Prompting

Prompting or supporting behavior refers to the assistance given to the child by some external source. Prompting in this program refers to the trainer helping the child perform a specified behavior in a more acceptable manner. For instance, the trainer may initially need to help guide the child's hand

to the button. The object of prompting is to facilitate initial learning. When the child is emitting the appropriate response, the prompts are slowly withdrawn by a process called fading.

Fading

Fading pertains to the successive withdrawal of a prompt. For example, if the trainer moved the child's hand to the button and used the child's hand to press the button in order to produce a reinforcement, then the child's behavior was prompted. The trainer should gradually reduce his physical support of the button-pushing response on succeeding trials until the child emits the desired behavior without assistance.

DETERMINING A REINFORCER

One of the most important aspects of operant audiometry is finding reinforcing stimuli for the child. Without reinforcers, building and maintaining the necessary responses are impossible. Many stimuli such as trinkets, candy, liquids, peanuts, ice cream, and raisins are typically reinforcing for many children, although wide variations in preferences always exist. Unusual items such as small blocks, nails, screws, parts of a puzzle, and small pieces of colored paper sometimes are reinforcing for specific children. Tokens, which can be exchanged for toys and food at a later time, are ideal if they can be conditioned as a generalized reinforcer. The general rule is to use a large number of potential reinforcers and then narrow the number of items when preferences become obvious with specific children.

Once a reinforcer has been isolated for a child, the next problem is to structure the situation so that the reinforcing event does not consume too much of the testing time. Many low-functioning children will play with food for many minutes before eating it, while others will sit and chew for what seems an eternity. If immediate consumption does not occur, one solution is to provide a small paper bag to hold the child's reinforcers. As the reinforcers are dispensed the trainer can help the child place them in the bag until the child does so spontaneously. Another solution is to deliver the reinforcer into a covered plastic container, which collects the reinforcers during the session. When the session is over the container is unlocked and the contents given to the child.

PERSONNEL INSTRUCTIONS

While the program is described in terms of two operators, one called a trainer and the other called an examiner, these functions may be combined simply by placing the necessary switches and audiometer controls in the testing room.

Trainer's Instructions

There are times in the program when a person must accompany a child into the testing room. This person, called the trainer in this manual, serves a valuable function that may either facilitate or hinder the acquisition of the required responses at different points in the program. The primary goal of the trainer is to help shape the desired behavior from the child.

To do this the trainer must be aware of the sequence of behaviors he wants the child to emit and the steps he will use to achieve this end. The trainer must remember that the end-goal of training must be attained through a series of steps. The ease with which the child attains the desired goal is, in a large part, determined by the skill of the trainer.[1]

The following principles should be understood by the trainer.

(1) Non-reinforcement of inappropriate behaviors. The trainer should never respond to an unwanted behavior in a manner that is reinforcing to the child. For example, if the child pushes the button with his nose, the trainer should probably ignore the behavior. However, the next time the child hits the button with his finger the trainer should say "good." These differential responses by the trainer should eliminate nose-pushing behavior and should increase finger-pushing behavior. Getting excited or agitated often serves as a reinforcer for the difficult-to-test child, so the trainer must learn to respond to an unwanted behavior in a way that will eliminate it most quickly.

(2) Reinforcement of appropriate behavior and small approximations to this behavior. If the child does not push the button correctly after several demonstrations, the trainer

[1] It has been the writers' experience that a high-level retardate who has been carefully trained can fill this role adequately in all but the very difficult cases.

should look for small indications of improvement in the direction of the desired response and prompt this behavior. For instance, if the child moves his arm in the direction of the button, the trainer should encourage this behavior. On the next trial the child may touch the button but may not depress it, and again the trainer should reinforce this behavior in some positive manner. On the next trial the child may rest his finger on the button but again may not depress it; the trainer should give the child a little physical prompt (touch his elbow so the button is depressed) and praise the child for responding appropriately. The trainer should continue assisting the child, but each time he should fade his support until the child is pushing the button by himself. The trainer should be careful not to reinforce a lesser approximation to the desired behavior than occurred on the previous trial. Once the child's hand is on the button, he should not be reinforced on a following trial for simply moving his arm toward the button.

(3) Non-relevant cues. As the child moves along in the program the trainer should be careful not to cue the child to respond at appropriate times. For example, if the trainer moves his head and looks toward the button each time the tone comes on, the child may learn to respond to these cues and not to the tone-on condition.

(4) General sensitivity. The individual variations within a population of difficult-to-test children are large; consequently, the trainer has to be constantly alert to the individual needs exhibited by each child in order to provide the optimal conditions

for that child to proceed through the program. Although major changes are not recommended, minor programatic variations are often required before a child can reach the terminal state of the program.

Examiner's Instructions

In most cases the examiner should be professionally trained in administering audiometric tests or should be closely supervised by an audiologist. The examiner remains in the control room, operates the equipment, and makes judgements concerning the progress of the child through the program. The examiner needs to be sensitive to the child's behavioral patterns in determining the effectiveness of the program. He must decide when the child should advance or when the child should back up to repeat some phase of the program, and he should be able to make modifications in the testing technique. The examiner must be familiar with the equipment so that he can manipulate the dials, buttons, and other manipulanda with a minimum of delay.

PHYSICAL ACCOMMODATIONS

The ideal physical setting is two separate rooms linked by a one-way mirror. The necessary programming equipment (see equipment section) and the audiometer are housed in one room. The other room contains the speaker, earphones, and the child's manipulandum (a button or lever in this program). It is preferable that the testing room be soundproof. A diagram of the testing situation is contained in Figure 1. Undoubtedly modifications will have to be made for the various facilities

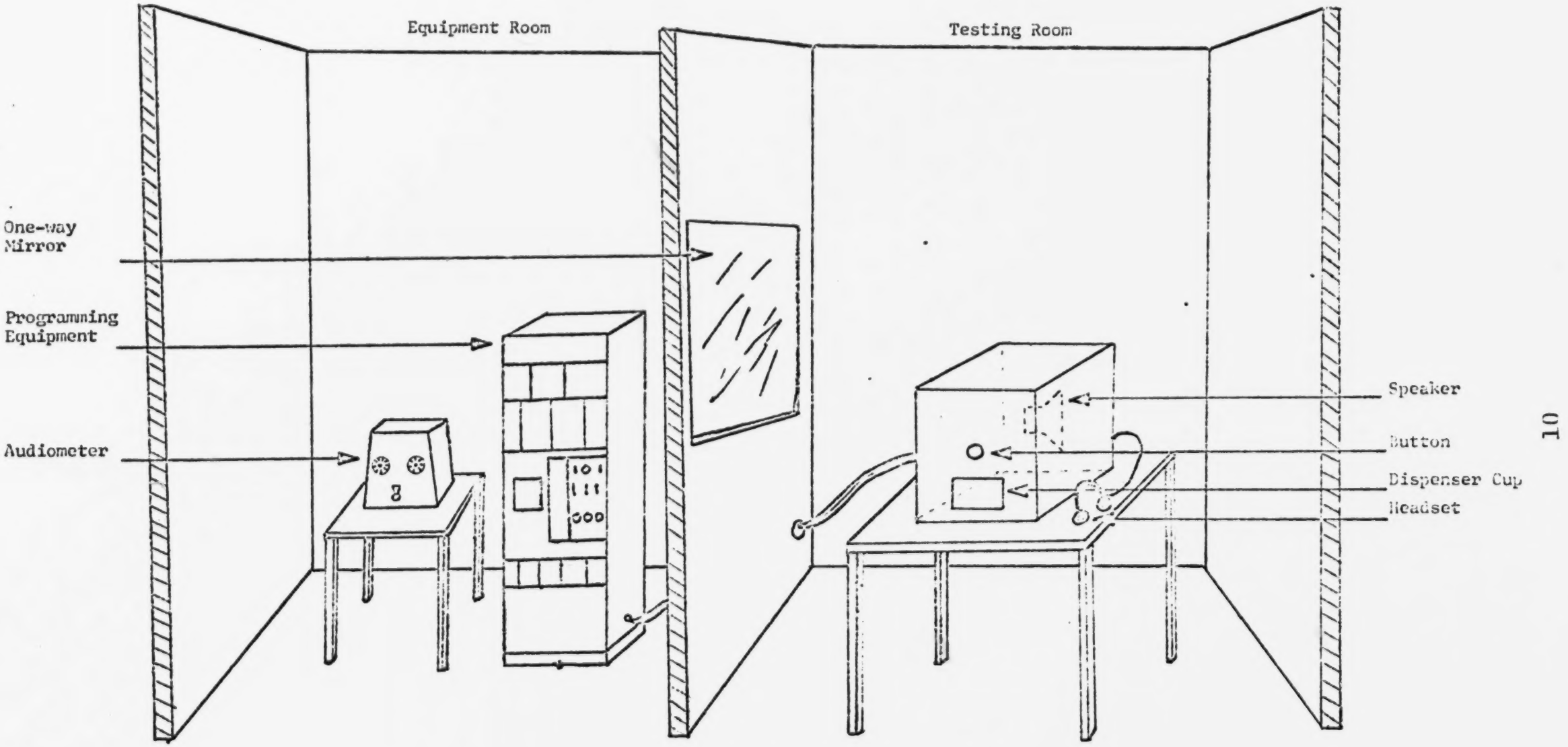

Figure 1. A diagram of the testing area for the operant audiometric procedure.

in which the program may be used.

It is important to empty the testing room of everything that is not essential for the actual procedure. The fewer manipulable or distracting objects in the testing room, the easier it will be to maintain the child's attention.

EQUIPMENT DESCRIPTION

The equipment necessary for use with operant audiometry techniques can vary from a simple system costing less than 20 dollars to one that costs about $1,500.00. The increase in price is associated with an increase in the precision, timing, and automation in the presentation of both the discriminative stimuli and the reinforcers. For the purpose of this manual, an apparatus was designed that would operate on 28 volts and would automate the critical functions of the program. The apparatus (see Figure 2) is activated by a switch closure input which can be a button, a telegraph key, or even a reconverted mop handle which the child can manipulate. When the examiner's switch is in the SD position the child's response will feed into a stepper which counts the responses up to the preset ratio value. When the ratio is met, a relay is activated which operates the reinforcement device and resets the stepper. The examiner's switch also controls the presentation of either or both the tone and light as the discriminative stimuli. When the examiner's switch is in the SΔ position, the child's responses will not operate the stepper and, in fact, will produce

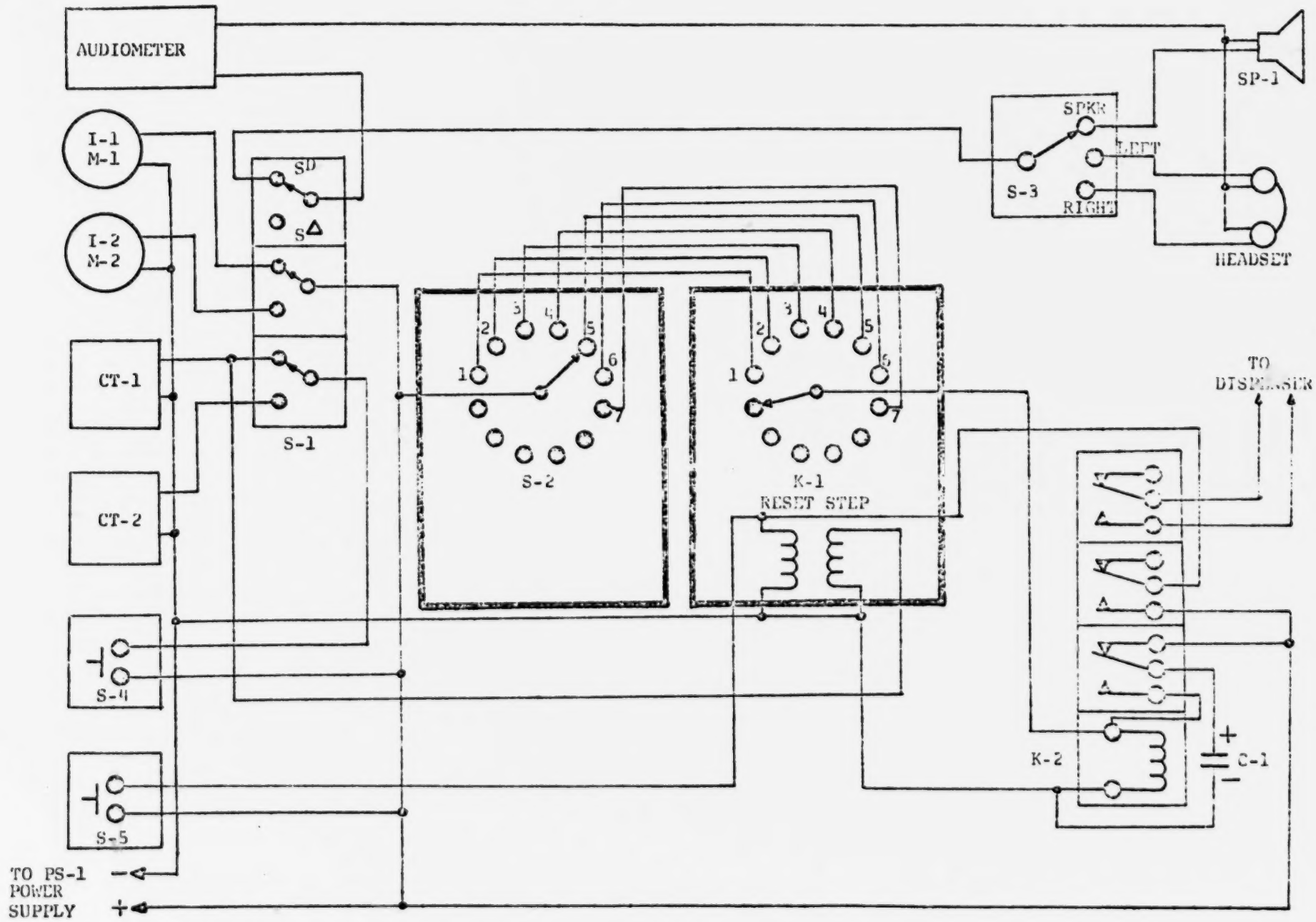

Figure 2. Schematic Diagram of Programming Equipment

no change in the apparatus, with the exception of activating the SΔ counter.

To use the apparatus, the examiner first sets the reinforcement ratio, the audiometer settings, the light settings (if used), and then brings the child to the testing room. When the child is settled, the examiner puts the toggle switch into the SD position and proceeds with subsequent steps of the program.

Since the equipment described here has no automatic timing device, the operator will have to provide some workable means (i.e., stop watch) for timing the tone-on and tone-off periods to coincide with the program specifications. Since responding during the tone-off period does not automatically reset the timer, the examiner must remember to reset the timing device each time the child responds during the tone-off period. If the tone-off time is 15 seconds, then 15 seconds should elapse between the child's last response in the tone-off period and the onset of the next tone-on period.

In the event that a power supply is not readily available, Figure 3 presents a schematic drawing of a simple to construct, 28 volt power supply. This power supply will operate the apparatus described in Figure 2.

If an automated reinforcement device is included in the apparatus, the cost will be substantially greater. There are several models available commercially that vary in cost from about $192.00 for a simple M&M dispenser[1] to $430.00 for a

[1] Candy Dispenser, Model MMD-1, Davis Scientific Instruments, 11116 Cumpston St., North Hollywood, California, 91601.

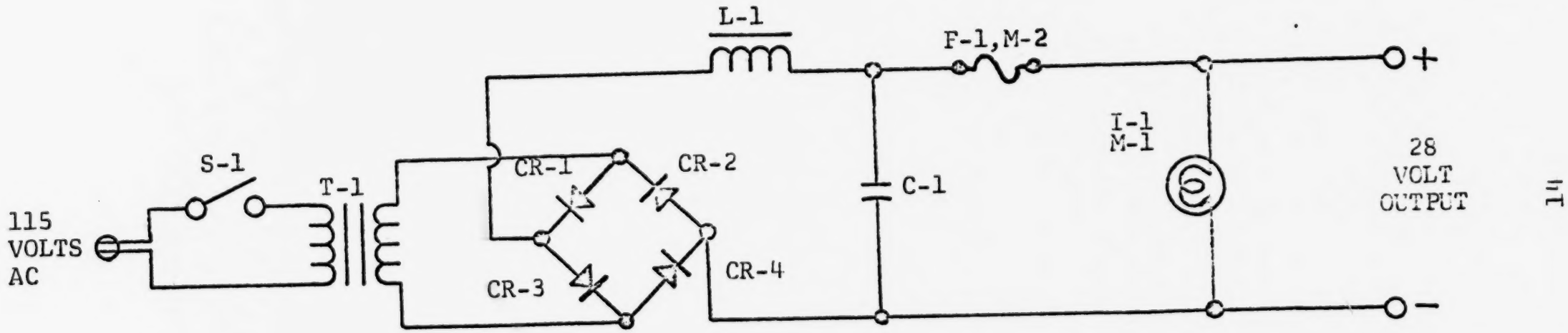

Figure 3. Schematic Diagram for 28 Volt DC Power Supply

versatile universal dispenser[1]. The latter device can dispense any object that measures up to one-half by one-half by two inches, including chewing gum, cigarettes, odd-shaped candy, tokens, and money. Another dispenser that is less expensive ($155.00) and yet provides automated reinforcement delivery is a marble dispenser[2]. The marbles can then be exchanged at the end of a given training or testing session for a variety of objects such as toys, candy bars, trinkets, clothes, or other reinforcing stimuli.

Electrical considerations in the design of the programming apparatus depend on the type of reinforcement device used. For example, (referring to Figure 2) if an M&M dispenser is used, the capacitor (C-1) will have to be approximately 100 MfD capacity to close the relay (K-2) for the required period of time. Shorter time requirements such as with a universal dispenser may need only a 50 MfD capacitor. Most people who are familiar with radio repair would have sufficient skill to adjust the capacitor to the time requirements of the dispenser.

While a dispenser is not an absolute requirement in the operant audiometry apparatus, it does add an important element to the procedure. The trainer could reach over and give the

[1] Universal Feeder, Model No. 310, Davis Scientific Instruments, 11116 Cumpston St., North Hollywood, California, 91601.

[2] Marble Dispenser, Model A, Motor Driven, Ralph Gerbrands Co., 8 Beck Road, Arlington, Massachusetts.

child a piece of candy, a token, or some other reinforcing stimulus contingent upon appropriate behavior. However, such an interaction may result in the trainer becoming the focus of much of the child's attention, which may disrupt, to some extent, the precision of the audiometric assessment. Consequently, a dispenser is recommended but not required.

EQUIPMENT COMPONENTS

Table 1 presents a list of the necessary components to construct the apparatus diagrammed in Figure 2, while Table 2 presents a similar component list for Figure 3. Listed are an item description, reference number, manufacturer's name, and manufacturer's number and price.

If help in assembling the equipment is needed, several sources within any community are available. Any university, college, junior college, or specialized training school that has either a physics or engineering department will probably have someone who could assemble the necessary apparatus. A high school shop teacher, as well as many TV repairmen, might have the necessary skills to assemble the programming equipment. See Appendix C for a detailed technical description of the operation of the component parts for the operant audiometry apparatus.

Table 1

Reference number, description, manufacturer, manufacturer's number and price of components for the construction of the apparatus appearing in Figure 2

Reference Number	Description	Note	Manufacturer	Manufacturer's Number	Price
I-1	SD Lamp, 28 Volt		General Electric	1819	.35
I-2	SΔ Lamp, 28 Volt		General Electric	1819	.35
M-1	Signal Assembly (Holds I-1)		Dialco	95-9110-0932-102	.73
M-2	Signal Assembly (Holds I-2)		Dialco	95-9110-0931-102	.73
CT-1	SD Response Counter		ITT General Controls	CE47AP4116	20.00
CT-2	SΔ Response Counter		ITT General Controls	CE47AP4116	20.00
S-1	SD-SΔ Switch		Culter Hammer	7612K2	2.93
S-2	Reinforcement Ratio Selector Switch		Mallory	32117J	1.56
S-3	Left-Right Speaker Switch		Mallory	3215J	1.02
S-4	Response Pushbutton	1	Grayson-Stadler	E8670A	35.00
S-5	Reset Pushbutton		Acro	3D05-5P	1.75
K-1	Stepper		Guardian	MER 24 Volt DC	15.75
K-2	Reinforcement Relay, 24 VDC, 3 PDT		Potter & Blumfield	KRP14DG	6.50
C-1	Delay Capacitor, 100 MFD to 500 MFD 50 WVDC	2	Sprague	TVA Series	1.50
SP-1	Speaker	3	-----	-----	-----
PS-1	Power Supply, 24-28 Volt DC	4	-----	-----	-----

1 An inexpensive but reliable response operandum is described by Bijou, S. W. Methodology for an experimental analysis of child behavior. Psychological Reports, 1957, 3, 243-250.

2 See text for selection of capacitor value, which depends on the type of dispenser used.

3 The speaker will have to be impedence matched to the audiometer used. Although the level does not have to be precisely determined, this will permit adequate volume to be obtained.

4 The power supply must be large enough to power the programming equipment as well as any reinforcement dispenser requiring external power, such as the Davis M&M Dispenser. If the latter is used, a four amp power supply will be required.

Table 2

Reference number, description, manufacturer, manufacturer's number and price of components used to construct the 28 volt DC power supply shown in Figure 3

Reference Number	Description	Manufacturer	Manufacturer's Number	Price
C-1	Filter Capacitor, 9000 MF at 50 WV	Sprague	902G050BC	4.27
CR-1,2,3,4	Rectifier	General Electric	IN3208	1.73 ea.
F-1	Fuse, 4 Amp	Littlefuse	3AG, 4 Amp	.39 (pkg. of 5)
I-1	Lamp, 28 Volt	General Electric	1819	.35
L-1*	Filter Choke	Chicago-Stancor	C2686	7.59
M-1	Signal Assembly (Holds I-1)	Dialco	95-9110-0931-102	.73
M-2	Fuseholder (Holds F-1)	Littlefuse	342024	1.24
S-1	On-Off Switch	Cutler Hammer	7580K4	.63
T-1	Transformer	Chicago-Stancor	P6378	9.57

* The filter choke can be omitted from the power supply, although this is not recommended.

OPERANT AUDIOMETRY PROGRAM

Step 1

The child is brought into the testing room by the trainer and both sit side-by-side so that the button and the dispenser cup are easily accessible to the child. Let the child examine and acquaint himself with his immediate surroundings, then restrict him to his chair if this can be achieved without upsetting the child.

Step 2

Equipment Settings: SD: 1000 Hz tone at 50-70 db through the speaker

Tone-on Time (SD): Unlimited

Tone-off Time (SΔ): Generally 5 seconds

Reinforcement Schedule: FR 1

When the child is sitting quietly, the examiner activates the audiometer that is connected to the speaker located in the testing room. A 1000 Hz 50 to 70 db tone should be used as the SD unless the child is suspected of having a hearing loss, and then the output should be increased. When the tone is turned on, the trainer should push the button while the child is watching his movements. The reinforcement ratio should be FR 1. When the previously determined reinforcement drops into the cup the examiner should turn off the tone, and the trainer should help the child retrieve the reinforcement if he should not do so spontaneously. When the child has eaten or otherwise disposed

of his reinforcer, the examiner should again turn on the tone and repeat the procedure. If the button-pushing response does not occur spontaneously on succeeding trials, the trainer should prompt the behavior by taking the child's hand slowly to the button. If the child resists, the trainer should let the child's arm go and again push the button himself, letting the child retrieve the reinforcer. On the following trial the trainer should again try to guide the child's hand to the button in a gentle manner. Once the child allows his arm to be moved to the button, the next step involves the fading of the button-pushing prompt until eventually the child is moving his hand to the button without any assistance. If the child is not spontaneously retrieving the reinforcers by this time, terminate the session until a more powerful reinforcer can be located. When the child is pushing the button spontaneously, move on to the next step.

IMPORTANT NOTE: Be sure the tone is <u>on</u> each time the trainer or child depresses the button.

<u>Step 3</u>

Equipment Settings: SD: 500 Hz tone at 50-70 db

Tone-on Time (SD): 20 seconds

Tone-off Time (SΔ): 10 seconds[1]

Reinforcement Schedule: FR 1

1 Each time the child responds during the SΔ period reset the tone-off time so that 10 seconds elapse between the child's last response in the tone-off period and the onset of the tone-on period.

From this point in the program to the introduction of the headset it is generally not necessary for the trainer to remain in the testing room.[1] When the child begins responding appropriately move on to the next step.

NOTE: If the child's rate of response is high (15-20 per SD period), move quickly to the next step before the child receives too many reinforcers.

Step 4

Equipment Settings: SD: 2000 Hz tone at 50-70 db
Tone-on Time: 15 seconds
Tone-off Time: 20 seconds
Reinforcement Schedule: FR 3

Step 5

Equipment Settings: SD: 4000 Hz tone at 50-70 db
Tone-on Time: 15 seconds
Tone-off Time: 30 seconds
Reinforcement Schedule: FR 5

[1] Some children will function suitably when left alone while others may engage in disrupting behaviors (crying etc.). The latter group will probably move through the program more rapidly if the trainer remains in the room. For a third group of children the trainer's presence serves as a hinderance rather than a facilitator. This group spends most of its energy in attending to the adult in the situation rather than the discrimination task. With this group it is imperative that the trainer leave the room as soon as possible.

NOTE: If the child's SΔ rate increases considerably, it may be necessary to return to Step 4 and fade into Step 5 more slowly. The examiner needs to be alert to the child's response patterns and make judgements in terms of moving on or backing up in the program. If a child continues to make as many responses in the tone-off condition as he does in the tone-on condition, see the Auxiliary Program in Appendix B.

Step 6

Equipment Settings: SD: 250 Hz tone at 50-70 db

Tone-on Time: 15 seconds

Tone-off Time: Varied between 7 to 45 seconds[1]

Reinforcement Schedule: FR 7

When the child's responding in the tone-off condition is limited (i.e., not more than 10 SΔ responses per minute of SΔ time) and responding in the tone-on condition is substantially greater (i.e., three or four times as many SD as SΔ responses), move the child on to the next step.

[1] A suggested schedule would be 15, 45, 10, 30, 7, and 15 seconds. These time variations are included to insure that the child is responding to the onset of the tone and not to the passage of a specific time period.

Step 7

Equipment Settings: SD: 6000 Hz tone at audible level[1] through earphones

Tone-on Time: Unspecified

Tone-off Time: Unspecified

Reinforcement Schedule: FR 7[2]

The tone is now directed through the headset rather than through the free field speaker. It is again necessary to have the trainer in the testing room in order to shape the child to wearing the earphones. The trainer should hold the earphone up to the child's ear and the examiner should turn on the tone. If the child does not push the button spontaneously, the trainer should prompt the behavior, remembering to fade the prompts rapidly. The child must be reinforced only in the presence of the tone when he is either wearing the earphones or making an approximation to wearing the headset. On each successive presentation of the tone the earphone should be moved closer to the child's ear until firm contact is made. Then the headset should be slipped on the child's head. If a negative reaction does not occur, move to the hearing test. However, if the child cries, fights, or otherwise resists, continue the procedure with the earphone beside his ear. Again, gradually

[1] The decibel level will be initially determined by how close the child will allow the earphone to be placed to his ear.

[2] Initially it may be wise to reduce the schedule to FR 1 or FR 2 in order to assure immediate reinforcement contingent upon wearing the headset.

working the headset back on; repeat this procedure until the child accepts the headset. Setting the situation so that no reinforcement will occur except when the headset is in place usually supplies ample motivation for wearing the headset.

Step 8

The final step is the actual hearing assessment using any audiometric technique comptatible with the equipment and the child's behavioral repertoire. During the initial portion of this step keep the tone clearly audible (necessarily a clinical judgement based on the child's previous response patterns). Good practice dictates that the first step should have the tone on for a large portion of the time so that the probability of reinforcement occurring will be greater than non-reinforcement. As usual, the child should never be reinforced for pushing the button when no tone is present.

During the hearing test the examiner should remain sensitive to behavioral cues emitted by the child. Some children develop routines or patterns of behavior (superstitious behavior) that may coincide with the tone coming on, and, as a result, the child may begin responding to an inappropriate cue rather than the tone-on condition. If any superstitious behavior develops, the examiner should be sure the tone-on condition does not coincide with the superstitious behavior in order to put it under extinction.

APPENDIX A

Summary of Steps for Equipment Settings

Step 1	Acclimate to surroundings
Step 2	SD: 1000 Hz tone at 50-70 db Tone-on Time: Unlimited Tone-off Time: Generally 5 seconds Reinforcement Schedule: FR 1
Step 3	SD: 500 Hz tone at 50-70 db Tone-on Time: 20 seconds Tone-off Time: 10 seconds Reinforcement Schedule: FR 1
Step 4	SD: 2000 Hz tone at 50-70 db Tone-on Time: 15 seconds Tone-off Time: 20 seconds Reinforcement Schedule: FR 3
Step 5	SD: 4000 Hz tone at 50-70 db Tone-on Time: 15 seconds Tone-off Time: 30 seconds Reinforcement Schedule: FR 5
Step 6	SD: 250 Hz tone 50-70 db Tone-on Time: 15 seconds Tone-off Time: Varied between 7 and 45 seconds Reinforcement Schedule: FR 7
Step 7	SD: 6000 Hz tone 50-70 db through the earphone Tone-on Time: Unspecified Tone-off Time: Unspecified Reinforcement Schedule: FR 7
Step 8	Hearing test

APPENDIX B

Auxiliary Program

This program can be used only if the equipment being used has the capacity to present a light as the SD (to coincide with the tone-on condition).

The following program is to be used in the event that the child does not demonstrate any learning in the initial program.

Step 1 — SD: 1000 Hz tone 80-90 db paired with a white light appearing in a panel situated above the button[1]
Tone-light-on Time: 20 seconds
Tone-light-off Time: 10 seconds
Reinforcement Schedule: FR 1

Step 2 — SD: 500 Hz tone paired with light
Tone-light-on Time: 15 seconds
Tone-light-off Time: 20 seconds
Reinforcement Schedule: FR 3

Step 3 — SD: 2000 Hz tone paired with light which is faded one step
Tone-light-on Time: 15 seconds
Tone-light-off Time: 30 seconds
Reinforcement Schedule: FR 5

Step 4 — SD: 4000 Hz tone paired with light faded two steps
Tone-light-on Time: 15 seconds
Tone-light-off Time: Varied between 7 & 45 seconds
Reinforcement Schedule: FR 7

Step 5 — SD: 250 Hz tone paired with light which is faded completely out
Tone-light-on Time: 15 seconds
Tone-light-off Time: Varied between 7 & 45 seconds
Reinforcement Schedule: FR 7

Step 6 — SD: 6000 Hz tone (no light)
Tone-on Time: 15 seconds
Tone-off Time: Varied between 7 & 45 seconds
Reinforcement Schedule: FR 7

[1] The presentation of the tone should occur 3-5 seconds before the light appears.

If the child continues to respond appropriately (that is, pushes the button in the presence of the tone and does not push the button in the absence of the tone), return to Step 7 of the original program. However, if the child begins responding inappropriately when the light is completely faded, return to Step 4 of the Auxiliary Program and repeat Steps 4, 5, and 6. If the child repeatedly responds inappropriately when the light is completely faded, one can assume that he probably does not hear the tone, or he can attach no significance to this stimulus.

APPENDIX C

Technical Description for the Operation of the Operant Audiometry Apparatus

The programming circuit shown in Figure 2 is designed to perform the following functions:

(1) Deliver reinforcement on a selectable fixed ratio (FR 1 to FR 21) schedule.

(2) Count and cumulate SD and SΔ responses.

(3) Present, alternately, SD and SΔ stimuli.

(4) Provide tone for presentation to the subject through the speaker, left earphone, or right earphone.

The ratio schedule is obtained through the combination of selector switch S-2 and stepper K-1. (Note: for reasons of clarity only 7 of the possible S-2 to K-1 interconnections are shown. For ratios up to FR 21 all of the contacts must be interconnected in the manner shown.) Responses are made on S-4, the response pushbutton. If S-1, the SD-SΔ switch is in the "up," or SD position, they will be totaled on CT-1, the SD counter, and will step the "step" coil of K-1. When sufficient responses have been made to step K-1 to the same contact as was preset on S-2 (in Figure 2 this is 5), a positive 28 volts will be connected, via contact 5 on S-2 and contact 5 on K-1, to the coil of the reinforcement relay, K-2. As K-2 operates, its top contact will operate the dispenser, its middle contacts will apply a voltage to the "reset" coil of stepper K-1, and its lower contacts

will connect the previously charged capacitor C-1 to its coil, providing for a short hold time. The value of C-1 is selected to provide sufficient time to operate the dispenser used -- the specific dispenser determining the value.

The middle contacts of S-1, the SD-SΔ selector switch, activate either I-1, the SD light, or I-2, the SΔ light. The top contacts of S-1 allows the audiometer output to be connected to the speaker or earphones only in the SD position.

Switch S-3 selects the desired tone output device -- i.e., speaker, left headphone, or right headphone. Finally, S-5 is a reset pushbutton by which the experimenter can reset the K-1 stepper back to "0" at any time in the program.

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